

# SESSION 2

- ▶ Dam Safety
- ▶ Importance and Issues



# Dam Safety is a Shared Responsibility



# Mission of TCEQ Dam Safety Program



# Mission

- To protect the lives, safety, and health of the public from dam failures or improper operation and to preserve the beneficial uses of dams and reservoirs.



# Mission

- To reduce these risks with an understanding of the limitations placed by technical, economic, political, and social concerns.



# What does this mean?

- The Dam Safety Program will assist the owner so the owner can maintain the dam in a safe condition to prevent loss of life and limit the potential for property loss. In doing so, the owner will reduce liability exposure and, with regular maintenance, will minimize costs.



# Dam Safety Program Assistance

- Perform inspections to identify problems and to train owners in making inspections at no cost.
- Meet with owners to discuss options for repairing dams
- Assist owners in preparing EAPs



# Engineers



# Need for an engineer

- ▶ All dams deteriorate with time
- ▶ Periodic inspection, proper maintenance, and occasional repair and rehabilitation become necessary
- ▶ Downstream development may result in hazard classification change and need to upgrade the dam
- ▶ Engineer provides the expertise to perform this work



# Engineer duties

- ▶ Investigate problems
- ▶ Design corrective measures
- ▶ Prepare plans
- ▶ Perform hydrologic and hydraulic analysis
- ▶ Perform inundation mapping for EAPs
- ▶ Assist in selecting a contractor



# Type of engineer to hire

- ▶ Texas Professional engineer
- ▶ Knowledgeable of the Texas Dam Safety rules and regulations
- ▶ Specific experience in the problem area
- ▶ An engineering company with an active Texas Board of Professional Engineers Firm Registration number



# Selection of an Engineer

- ▶ Public entities must use a qualification based approach (determining factors are knowledge, experience, and ingenuity)
- ▶ Request for Qualifications (RFQ)
- ▶ Selection is then based on most qualified
- ▶ Price is negotiated after most qualified engineer has been identified
- ▶ Private owners can select by use of a fee-based process, the engineer's fee is only factor in the process



# What an owner needs to do

- ▶ Request and contact references
- ▶ Check out other projects designed by engineer
- ▶ Keep in touch with Dam Safety Program
- ▶ Become knowledgeable in the basics of dam safety
- ▶ Carefully consider the selection of engineer
- ▶ Request options, if possible, for addressing the problem



# Importance



# How many dams do we have in Texas?

- There are 7,231 dams in the Inventory of Dams, including federal dams



# # of dams that would impact people downstream

- 1,758 (1,640 in 2006)
  - 1,062 high hazard, excluding federal dams (probable loss of life if dam fails) (830 in 2006)
  - 696 significant hazard (possible loss of life if dam fails) (810 in 2006). Includes exempt dams



“Since millions of people live practically in the shadows of major dams, it is imperative that increasing attention be given to finding the best ways to ensure protection.”

▶ Robert Jansen, 1980



# Issues

- Aging of Dams
- Dam Failures
- Increasing Hazard
- Liability
- Hydrologic and Hydraulic Analyses
- Legislation
- FEMA documents



# Aging of Dams



Does 50 years of, apparently,  
successful operation assure  
continued safe operation?



# Aging of Dams

- In Texas, over 91% of the Inventory size dams are 25 years old or older.
- Nearly 42% are 50 years old or older



“Age brings about an increased need for maintenance of the dam and, it becomes more expensive.”

▶ National Watershed Coalition, 2010



# Aging of Dams

- Aging can contribute to incidents or failures through:
  - Piping/seepage
  - Concrete deterioration
  - Settlement
  - Geotextile deterioration
  - Gate deterioration



# Aging of Dams

- ▶ For example:
  - Seepage may increase due to aging of drainage systems or grout curtains or dissolution of foundation or embankment materials.
  - Drainage systems can plug.
  - Geotextiles can age and deteriorate.
  - Cracking of embankments may result in increase in long term pore pressure







# Dam Failures



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# Dam Failures

- ▶ Dam failure floods are almost always more sudden and violent than normal stream floods
- ▶ A dam failure often produces damage that looks like tornado damage



# Dam Failures Resulting in Fatalities

- 86% of the fatalities resulted from dams between 20 and 49 feet in height.
- 47% of the fatalities resulted from dams with drainage area less than 2 sq. mi.
- 75% of the fatalities resulted from dams with drainage area less than 10 sq. mi. (90% of Texas watershed dams and 80% of all dams)
- 7 dams had less than 300 ac-ft of water released during the failure.





# Kelly Barnes Dam, Georgia

- ▶ 40 feet high, 410 AF
- ▶ 39 people died
- ▶ \$2.8 million in damages





# Kaloko Dam, Hawaii

- ▶ 40 feet high, 1,200 AF
- ▶ 7 people died
- ▶ Multiple law suits
- ▶ 7 charges of manslaughter
- ▶ \$1.5 million assessed to state
- ▶ \$25 million total assessment



# Dam Failures in Texas

- ▶ Since 1900, there have been 167 dam failures, overtopping events with no failure, or structural failures of slopes with no failure of dam
- ▶ Two dams have failed with loss of life
  - Lake Austin Dam – 13 died
  - Nix Club Dam – 1 died



# Dam Failures

- ▶ Failures occur from the following:
  - 34% from overtopping
  - 30% from foundation defects and slope instability
  - 20% from piping or seepage



# Dam Failures

- ▶ Dam Failures from 1975 – 2001
  - Nearly 70% due to overtopping
  - 15% from seepage or piping





01/27/2012











# Watershed Dams Do Fail!



# Damages from Dam Failures

- Loss of life
- Personal injury
- Emotional distress
- Health issues later in life
- Property damage:
  - Diminished value
  - Restoration costs and/or replacement costs





# Increasing hazard



# Increasing Hazard

- People constructing houses downstream of dams without realizing that a dam exists
- Dams that used to be out in rural areas affecting nothing but open fields, are now affecting neighborhoods and industrial areas, increasing dam failure consequences

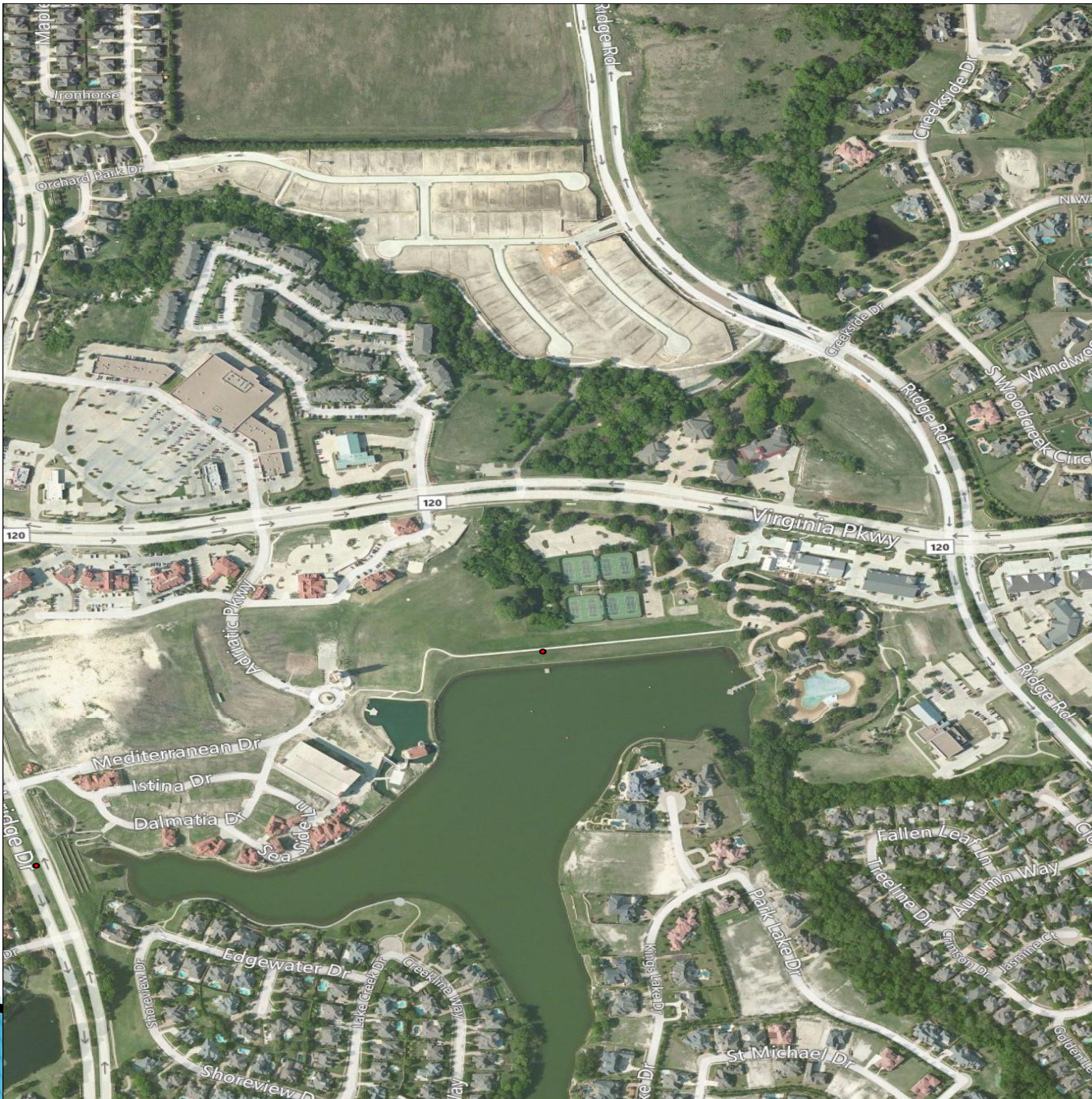


# Issue

- How do we address the issue of people building or developing downstream of dams with the result being owners of dams needing to upgrade dams with limited resources?











07/19/2011



# Hazard Reclassification

- All reclassifications of hazard by the Dam Safety Program will require ground truthing to determine if buildings are inhabitable houses or barns or sheds.
- May also require the Program to perform either a simplified or full breach analysis



# Liability



# Liability

- Who is responsible for safety and liability?
  - Owners of dams
  - Those entities responsible for O&M at the dams



# Basic Legal Premises

- ▶ “In today’s litigious society it is safe to assume that in the case of a catastrophic dam failure, extensive litigation will ensue. Any competent lawyer, representing the victims will sue all possible wrongdoers in seeking redress.”

- ▶ Dr. Dennis Binder



# Basic Legal Premises

- Lawsuits will claim extensive liability on the part of everyone involved in the dam failure incident



# PREMISES

We live In a litigious society.

**Sue them all.**

- |                  |            |
|------------------|------------|
| • ARCHITECTS     | OWNERS     |
| • ENGINEERS      | OPERATORS  |
| • DESIGNERS      | INSPECTORS |
| • CONTRACTORS    | REGULATORS |
| • SUBCONTRACTORS | EMPLOYEES  |

- OVERRIDING PURPOSE OF MODERN TORT LAW IS TO COMPENSATE INNOCENT VICTIMS FOR INJURIES CAUSED BY WRONGDOERS



Perception can mean more  
than facts



# Common Law

- Common law holds that the storage of water is a hazardous activity
- Whoever captures the water is liable for any damages the activity may cause others



# Duty

- ▶ Failure to exercise the standard of care of a reasonable person under the circumstances
- ▶ Often based upon the reasonable foreseeability of the risk
- ▶ How would a reasonable person act in light of that risk?
- ▶ Legal duty of reasonable care is a calculus of three factors:
  - – Risk of an accident occurring;
  - – Magnitude of harm should the risk materialize;
  - – Availability of alternatives.
- ▶ Flexible standard
  - – Varies with risks, population, technology
  - – The higher the risk the higher the standard of care
  - – Varies with downstream development
- ▶ Extends to all those foreseeably at risk.



# Foreseeability

- ▶ Reasonable foreseeability can be based on prior incidents
- ▶ Hindsight is the best test



# Hydrologic and Hydraulic Analyses



# Flood Risk

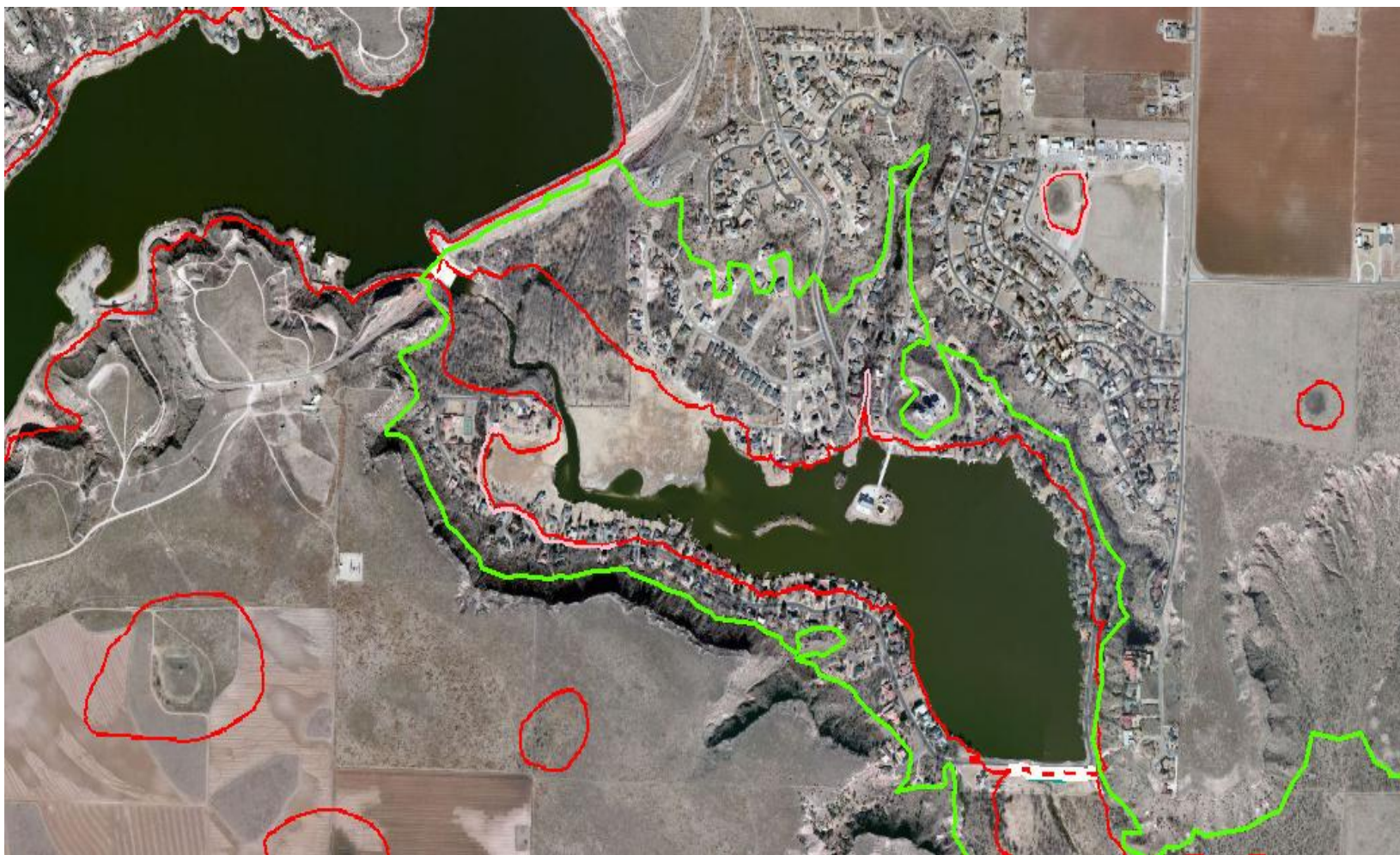
- ▶ Flood risk is not just based on history
- ▶ Just because you experienced a 100-year flood doesn't mean you will not experience another one.
- ▶ Flood risk is based also on potential dam failures, rainfall, upstream changes to topography, and downstream development



# 100-Year Flood

- ▶ The flood that has a 1 percent-annual-chance of being equaled or exceeded
- ▶ Is not intended to be a safety standard
- ▶ Dam failure flood events may far exceed the 1 percent flood zones
- ▶ Floods greater than a 100-year flood can and do happen (two 500-year floods in a 15 year period in Midwest in 1993 and 2008)





# Hydrologic and Hydraulic Studies

- 65 to 70% of high and significant hazard dams are either hydraulically inadequate, or there is no record of a study
- Rules do not require; however, a recommendation is being made to owners that a study should be undertaken



# Hydrologic and Hydraulic Studies

- Cost for a study is high (Average cost \$15,000 to \$20,000 per dam). This cost does not include any costs for modifying the dam and/or spillways
- No state funds for studies
- Plan of action should allow time for budgeting and doing the study



# Is the Probable Maximum Flood Unreasonable

- ▶ If a similar storm has occurred, could be anticipated using modern techniques, or was otherwise reasonably foreseeable, even if not probable, claiming an act of God will not successfully serve as a defense.



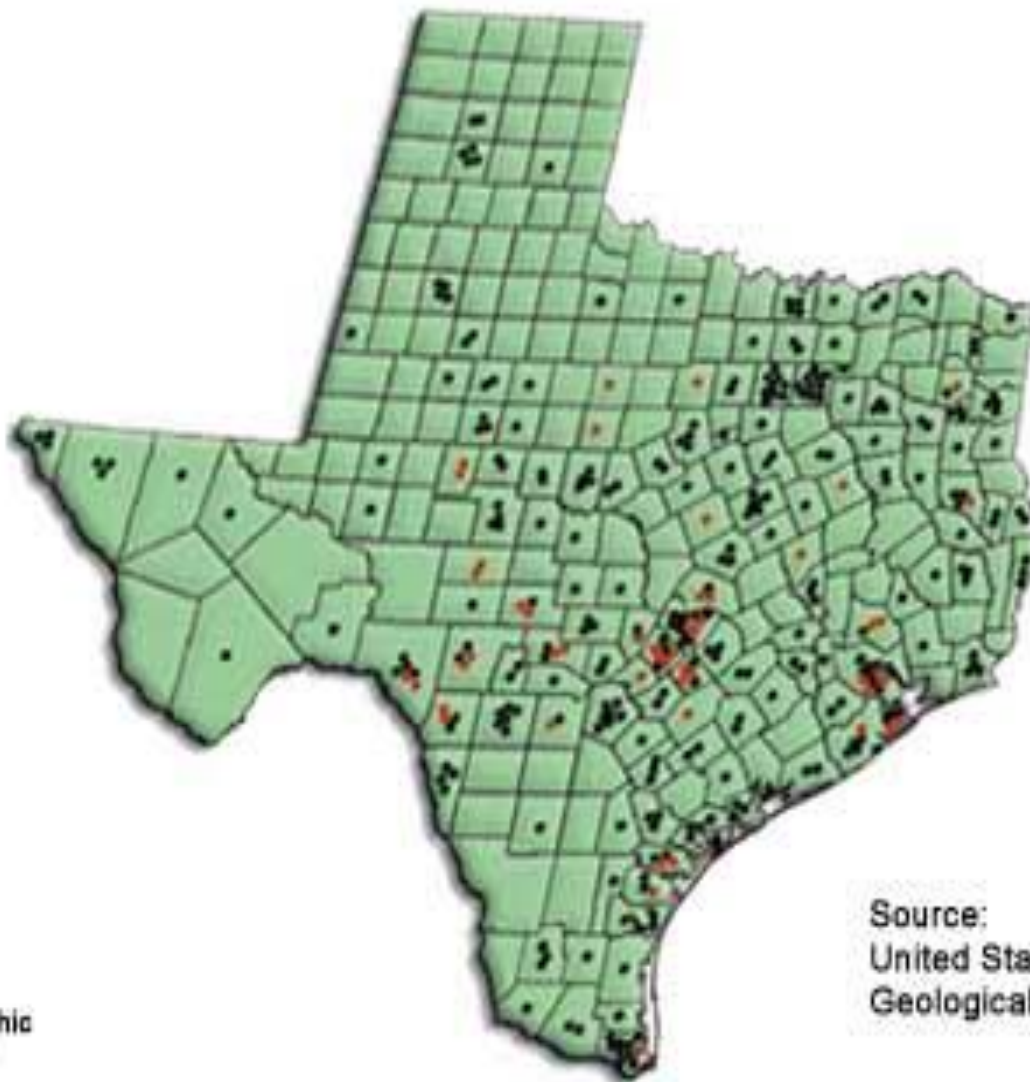
# Colorado Court case

- Court rejected defense of act of God and held defendants negligent in designing an inadequate spillway.
- Since the flow of water was reasonably foreseeable, there is no act of God
- The foreseeability of risk, that is, the probable maximum flood, was the key to liability



## Storm Type & Location

- Major
- Catastrophic



Source:  
United States  
Geological Survey



# Rainfall events

- Hearne 1899 30 inches in 24 hours 66% of PMF
- Thrall 1921 38 inches in 24 hours 86% of PMF
- Alvin 1979 43 inches in 24 hours
- Medina 1978 31 inches in 24 hours 73% of PMF  
and 48 inches in 52 hours 98% of PMF
- Albany 1978 29 inches in 24 hours with 23 inches  
in 8 hours 73% of PMF



# Rainfall events

- Odem 1984 26 inches in 4 hours 81% of PMF
- Woodville 1996 13 inches in 4 hours (10 dam failures)
- Marble Falls 2008 18 Inches in 9 hours, 9 inches in 1 hour



# Legislation



# Legislation (2011)

- Focus the program on the most hazardous dams
- Agreements with dam owners
- Exemption of dams



# Legislation (2011)

- Exemption of dams
  - Privately owned;
  - Maximum capacity (top of dam capacity) of less than 500 acre-feet;
  - Low or significant hazard dam;
  - Located in a county with a population of less than 215,000; and
- Not located inside the corporate limits of a municipality



# Legislation (2011)

- The owners of exempted dams still shall comply with operation and maintenance requirements.
- The exemptions will expire on August 31, 2015.
- Does not exempt owner from liability.



# Legislation (2013)

- Exemption of dams
  - Privately owned;
  - Maximum capacity (top of dam capacity) of less than 500 acre-feet;
  - Low or significant hazard dam;
  - Located in a county with a population of less than 350,000; and
  - Not located inside the corporate limits of a municipality



# Legislation (2013)

- The exemption is permanent. It does not mean that the dam is permanently exempt
- Nearly 3,200 dams exempt
- 216 significant hazard dams exempt



# FEMA documents



# Living with Dams: Know your Risks



# Community Rating System (CRS)



# What is CRS?

- ▶ CRS is a system for a community to obtain discounts on flood insurance rates
- ▶ There is a section on Dam Safety in the rating system



# So how does that affect the dam owner?

- ▶ Under the current proposal, floodplain managers will be requesting a copy of inundation maps for all high hazard dams that affect their community
- ▶ Owners may also be contacted on a quarterly basis for information.
- ▶ TCEQ will not provide copies of inundation maps or a list of high hazard dams due to Homeland Security



# Emergencies

- Can you get there if there is an emergency?
- Will everything work when you get there?



# How Do We Blend the Different Responsibilities and Issues?

- Communication
- Request reevaluation of hazard classification if you do not agree
- Request another inspection/meeting to discuss findings/issues
- Ask engineers for options



# How Do We Blend the Different Responsibilities and Issues?

- Remove the dam or make it a non-dam
- Time payments on study costs?
- All parties need to seek ways to blend the engineering, regulations, and owner costs



“In no other field of engineering is the responsibility to the public heavier or more exacting.”

▶ Robert Jansen, 1980



# Questions

